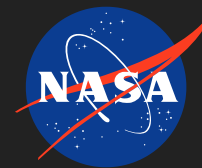


Achromatic Phase Shifting Mask for High Performance PIAA Coronagraphy

Completed Technology Project (2013 - 2017)



Project Introduction

The direct imaging and characterization of Earth-like extrasolar planets is one of the most prominent goals of modern astrophysics. The main technological challenge for direct imaging is to block the glare and diffraction from the star so that the faint planet light located close to the star can be seen. High performance coronagraphs are the most likely tool to overcome this technical challenge. With this NASA Space Technology Research Fellowship, I propose to develop and demonstrate an achromatic phase-shifting focal plane mask, which will provide significant improvement to almost any high performance coronagraph. An achromatic focal plane mask will provide a broader observational band, improved inner working angle and contrast, increased science yield, and reduction of required telescope diameter and complexity. More specifically, the goal of this NSTRF is to develop an achromatic focal plane mask for the Phase-Induced Amplitude Apodization Complex Mask Coronagraph (PIAACMC) (Guyon 2010). PIAACMC operates by applying a λ phase shift to a portion of the on-axis starlight using a partially transmissive phase shifting focal plane mask. The use of a Lyot stop induces interference between the phase shifted and un-shifted starlight, which results in total on-axis starlight extinction. PIAACMC provides 50% throughput at $0.64 \lambda/D$ and nearly 100% throughput at large angular separations. These performance characteristics are very close to the fundamental physical limit for any instrument. The focal plane mask needs to provide a constant phase shift for all wavelengths within the observing bandwidth. However, applying a phase shift is not an inherently achromatic operation. Along with Dr. Guyon and Dr. Belikov, I have developed and tested a method to create achromatic focal plane masks using a diffractive optical filtering technique (Belikov 2003). By applying a similar concept, we can develop an achromatic phase shifting mask suitable for PIAACMC. The proposed research directly addresses technology area 8.1.3.1, Starlight Suppression, and is complimentary to Dr. Guyon's OCT funded research at the University of Arizona, which addresses wavefront control for segmented apertures. The proposed research is also complimentary to research at the Ames Coronagraph Experiment laboratory, which is an ideal location for the NASA on-site experience. The proposed mask design and demonstration will also serve as my PhD dissertation topic.

Anticipated Benefits

An achromatic phase-shifting focal plane mask will provide significant improvement to almost any high performance coronagraph. An achromatic focal plane mask will provide a broader observational band, improved inner working angle and contrast, increased science yield, and reduction of required telescope diameter and complexity.



Achromatic Phase Shifting Mask
for High Performance PIAA
Coronagraphy

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

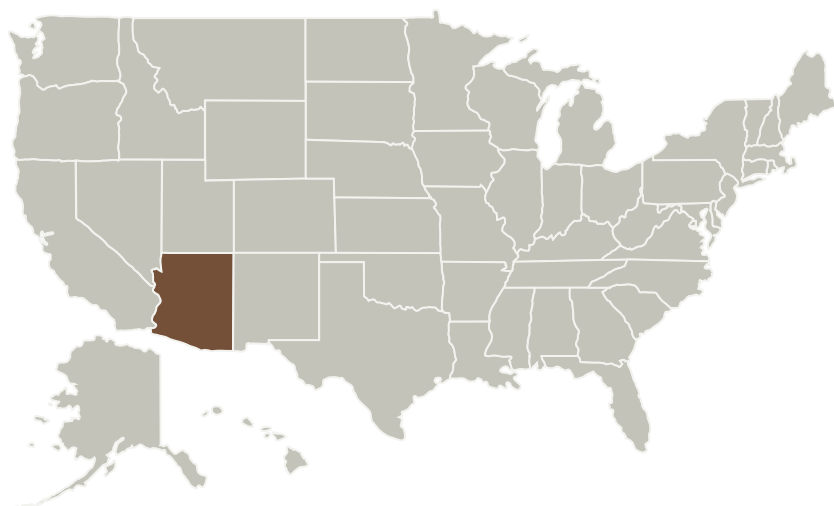
Space Technology Research Grants

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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Arizona	Supporting Organization	Academia Alaska Native and Native Hawaiian Serving Institutions (ANNH)	Tucson, Arizona

Primary U.S. Work Locations

Arizona

Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

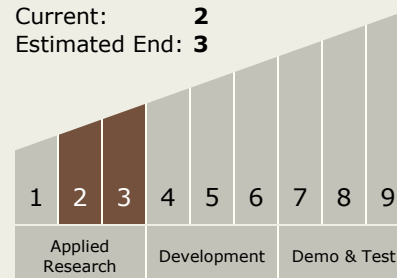
Olivier Guyon

Co-Investigator:

Kevin E Newman

Technology Maturity (TRL)

Start: 2
Current: 2
Estimated End: 3



Technology Areas

Primary:

- TX08 Sensors and Instruments
 - TX08.1 Remote Sensing Instruments/Sensors
 - TX08.1.1 Detectors and Focal Planes